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METASTABILITY AND COMPENSATED COMPACTNESS IN CONTINUUM
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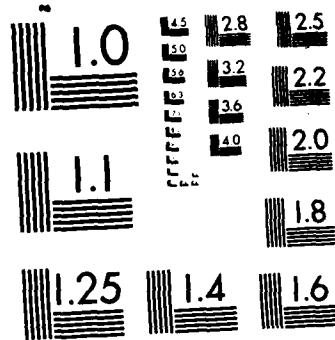
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INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS
University of Minnesota

Final Technical Report

Research Agreement DAAG 29-85-K-0021

George R. Sell
Associate Director
January 23, 1986

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* The Proceedings of these workshops will be published by Springer Verlag in the IMA Volumes in Mathematics and its Applications.

INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS
University of Minnesota

CONTINUUM PHYSICS AND PARTIAL DIFFERENTIAL EQUATIONS

WORKSHOP ON
OSCILLATION THEORY, COMPUTATION, AND METHODS OF COMPENSATED COMPACTNESS

April 1 - April 6, 1985

Conference committee: Constantine Dafermos, Jerry Ericksen, David Kinderlehrer,
Marshall Slemrod

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Historically, one of the most important problems in continuum mechanics has been the understanding of hyperbolic conservation laws. This is because such systems arise from the underlying balance laws of mass, momentum, and energy. Their nonlinearity and hyperbolicity arise from the simplest constitutive assumptions, even in an ideal gas. The goal of this workshop is to examine the implications of compensated compactness and dispersion in the analysis and numerical analysis of such equations. The influence of viscosity and fluctuation mechanisms in nature will be discussed as well. Recently there has been remarkable progress in all of these fields.

Participants will include representatives of these areas. Since one of the ultimate users of these ideas will be the applied engineer or scientist engaged in numerics, those in the forefront of applying theory and writing codes will be sought.

Philip Colella	Lawrence Berkeley Laboratory
R. DiPerna	Princeton University
Ami Harten	University of California, Los Angeles
George Hermann	Stanford University
Barbara Keyfitz	University of Houston
Peter Lax	Courant Institute
T.P. Liu	University of Maryland
D. Levermore	Lawrence Livermore Laboratory
Andrew Majda	Princeton University
D. McLaughlin	University of Arizona
Jace Nunziato	Sandia Natl. Laboratory
Stanley Osher	University of California, Los Angeles
Robert Pego	I.M.A. and University of Michigan
O. Pironneau	I.N.R.I.A.
Michael Rascle	Universite de Saint-Etienne
V. Roytburd	Rensselaer Polytechnic Institute
Maria Schonbek	Princeton University
Denis Serre	Universite de Saint-Etienne
Luc Tartar	Centre d'Etudes de Limeil
S. Venakides	Stanford University
Robert Warming	NASA Ames Laboratory
Helen Yee	NASA Ames Laboratory
L.C. Young	University of Wisconsin

IMA activities are open. The public is cordially invited to participate.

OSCILLATION THEORY, COMPUTATION, AND METHODS OF COMPENSATED COMPACTNESS

April 1-5, 1985

Colella

"Oscillations in Solutions to Nonlinear Differential Equations"
Ronald J. DiPerna

"On High-Order Accurate Interpolation For Non-Oscillatory Shock Capturing Schemes"
Ami Harten

Lax

"Nonlinear Geometric Optics for Hyperbolic Systems of Conservation Laws"
Andrew Majda

McLaughlin

Nunziato

Osher

"Convection of Microstructures by incompressible and slightly compressible flows"
T. Chacon and O. Pironneau

"Convergence of Approximate Solutions to Some Systems of Conservative Laws:
A Conjecture on the Product of the Riemann Invariants"
Michel Rascle

"Applications of the Theory of Compensated Compactness"
M.E. Schonbek

"A General Study of a Commutation Relation given by L. Tartar"
Denis Serre

"Interrelationships among Mechanics Numerical Analysis, Compensated Compactness,
and Oscillation Theory"
M. Slemrod

"The Solution of Completely Integrable Systems in the Continuum Limit of the
Spectral Data"
Stephanos Venakides

"Construction of a Class of Symmetric TVD Schemes"
Helen Yee

INSTITUTE FOR MATHEMATICS AND ITS APPLICATIONS
University of Minnesota

CONTINUUM PHYSICS AND PARTIAL DIFFERENTIAL EQUATIONS

WORKSHOP ON

METASTABILITY AND INCOMPLETELY POSED PROBLEMS
May 6-10, 1985

Conference Committee: Stuart Antman, Jerry Ericksen, David Kinderlehrer, and Ingo Müller

Most equilibrium events in nature do not actually realize configurations of minimum energy. They are only metastable. The configurations may not be unique, and it may not be possible to know all the boundary conditions or constitutive relations. The purpose of this workshop is to approach these questions through the viewpoints of the material scientist and the mathematician. Significant activity has been underway in recent years from the experimental arena and physical theory to the analysis of differential equations and computation.

The study of nonconvex variational problems is becoming a vigorous area of both theory and applications. Questions of constitutive description, transition to stable or metastable phases, as well as issues suggested by generalizations of St.-Venant's principle will be of primary concern.

John Ball	Heriot-Watt University
Romesh Batra	University of Missouri
Henri Berestycki	Ecole Polytechnique
Haim Brezis	University of Paris
John Cahn	National Bureau of Standards
Michael Crandall	University of Wisconsin
Alan Gent	University of Akron
Nigel Goldenfeld	Institute for Theoretical Physics, Santa Barbara
Morton Gurtin	Carnegie-Mellon University
George Herrmann	Stanford University
Cornelius Horgan	Michigan State University
Richard James	Brown University
Robert Kohn	Courant Institute
Steven Montgomery	Sandia National Laboratory
Umberto Mosco	Universita di Roma
Gerry Moss	Aberdeen Proving Grounds
Robert Muncaster	University of Illinois
Mario Pitteri	Universita di Padova
P. Podio-Guidugli	Universita di Pisa
Robert Rodgers	Mathematics Research Center
Joel Spruck	University of Massachusetts - Amherst
Luc Tartar	Centre d'Etudes de Limeil
Piero Villaggio	Universita di Pisa
T. Wright	Aberdeen Proving Grounds

IMA activities are open. The public is cordially invited to participate.

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Workshop on Metastability and Incompletely Posed Problems

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Dissipative Mechanisms

Stuart S. Antman and Reza Malek-Madani

Does Rank-one Convexity Imply Quasiconvexity?

J.M. Ball

Twinning of Crystals (I)

J. Erichsen

Introduction to Pattern Selection in Dendritic Solidification

Nigel Goldenfeld

Some Results and Conjectures in the Gradient Theory

Morton Gurtin

The Stability and Metastability of Quarts

R.D. James

Continuation Theorems for Schrödinger Operators

Carlos E. Kenig

Simulation of Pseudoelastic Behaviour in a System of Rubber Balloons

Wolfgang Kitsche, Ingo Müller, Peter Streblow

Variational Stability and Relaxed Dirichlet Problems

Umberto Mosco

Hyperbolic Aspects in the Theory of the Porous Medium Equation

Juan Luis Vazquez

Some Aspects of Adiabatic Shear Bands

T.W. Wright

LIST OF PUBLICATIONS
of IMA Participants whom received
partial or full support from

Research Agreement DAAG29-85-K-0021

Antman, Stuart

1. Dissipative Mechanisms. To appear in the Proceedings of the Workshop on Metastability and incompletely posed problems. Springer-Verlag.

Aviles, P.

1. Local Behavior of Solutions of Some Elliptic Equations. IMA Preprint No. 178, 1985.

Beirao da Veigo, Hugo

1. Existence and Asymptotic Behavior for Strong Solutions of the Navier-Stokes Equations in the Whole Space. To appear in the Proceedings of the Workshop on Dynamical Problems in Continuum Physics. Springer-Verlag.

Bona, Jerry

1. (with B. Bozar-Karakiewicz) Wave-dominated Shelves: A Model of Sand-Ridge Formation by Progressive, Infragravity Waves. IMA Preprint No. 150, 1985. To appear in the C.S.P.G. memoir on shelf sands and sandstones.
2. (with Dougalis and Karanckashian) Fully Discrete Galerkin Methods for the Korteweg De Vries Equation. IMA Preprint No. 182, 1985. To appear in J. Comp. & Math. with Applic.
3. (with Boczar, Karakiewicz and Cohen) Shallow-water Waves and Sediment Transport. To appear in the Proceedings of the Workshop on Dynamical Problems in Continuum Physics. Springer-Verlag.

Chipot, M.

1. (with G. Vergara-Caffarelli) The N-Membranes Problem. IMA Preprint No. 131, 1985. Appl. Math. and Opt. 13 (1985), p. 231-249.
2. (with P. Eymard and T. Tahani) Sur les fonctions propres de l'operateur de Laplace-Beltrami dont le carre est fonction propre. To appear in Proc. of a Sympos. in Pure Math. - Acad. Press.
3. (with L.C. Evans) Linearization at infinity and Lipschitz estimates for certain problems in the calculus of variations. To appear in Proc. of the Royal Soc. of Edinburgh.
4. (with M. Luskin) Existence and uniqueness of solutions to Reynold's lubrication equation. To appear in SIAM Journal of Analysis.

Chipot, Michel (Continued)

5. (with D. Kinderlehrer and G. Vergara Caffarelli) Some smoothness properties of Linear Laminates.
6. On the Reynolds Lubrication Equation. IMA Preprint Series No. 206, 1985.
7. (with M. Luskin) The Reynolds Lubrication equation in the compressible case.
8. (with T. Sideris) On the Abelian Higgs Model.
9. (with V. Oliker) Sur une propriété des fonctions propres de l'opérateur de Laplace Beltrami.
10. (with F. Weissler) Blow up results for parabolic equations with non linearity in Gradient.

DiPerna, R.

1. Oscillations in Solutions to Nonlinear Differential Equations. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness. Springer-Verlag.

Goldenfeld, Nigel

1. Pattern selection in dendritic solidification. To appear in the Proceedings of the Workshop on Metastability and Incompletely Posed Problems. Springer-Verlag.

Gurtin, M.

1. Some Results and Conjectures in the Gradient Theory of Phase Transitions. IMA Preprint No. 156, 1985.
2. Phase transitions with Interfacial Energy. To appear in the Proceedings of the Workshop on Metastability and Incompletely Posed Problems. Springer-Verlag.

Harten, Ami

1. On High-order Accurate Interpolation for Non-Oscillatory Shock Capturing Schemes. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness.

James, Richard

1. Stress-free joints and polycrystals. *Arch. Rational Mech. Anal.* 86, (1984), p. 13-37.
2. The stability and metastability of quartz. Metastability and Incompletely Posed Problems. Springer-Verlag Lecture notes in Mathematics, to appear.

Kohn, R.

1. (with M. Vogelius) Thin Plates with Rapidly Varying Thickness, and Their relation to Structural Optimization. IMA Preprint No. 155, 1985. Proceedings of Workshop on Homogenization and effective moduli, to appear.
2. (with G. Milton) On bounding the effective moduli of anisotropic composites. Proceedings of the Workshop on Homogenization and Effective Moduli, to appear.
3. (with Y. Giga) Characterizing blow-up using similarity variables. IMA Preprint No. 200, 1985. Submitted to Indiana University Math. Journal.
4. (with G. Buttazzo) Reinforcement problems with oscillating boundaries, in final stages of preparation.
5. (with G. Milton) Bounds for anisotropic composites by variational principles, in preparation.

Leizarowitz, Arie

1. Tracking Nonperiodic Trajectories with the Overtaking Criterion. IMA Preprint No. 138, 1985.
2. Convex Sets in R^n as Affine Images of some Fixed Set in R^n . IMA Preprint No. 139, 1985.
3. Stochastic Tracking with the Overtaking Criterion. IMA Preprint No. 140, 1985.

Liu, T.P.

1. Nonlinear Stability and Instability of Waves. To appear in the Proceedings of the Workshop on Metastability and Incompletely Posed Problems. Springer-Verlag.

MacSithigh, Gearoid

1. Homogeneous energy minimizers for the dead load traction problem in multiply constrained finite elasticity. In advanced state of preparation.
2. A bifurcation problem in multiply constrained finite elasticity. In advanced state of preparation.
3. Bifurcation and stability of Mooney-Rivlin solids under homogeneous dead loads. In advanced state of preparation.

Majda, Andrew

1. Nonlinear Geometric Optics for Hyperbolic Systems of Conservation Laws. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation and Methods of Compensated Compactness. Springer-Verlag.

Osher, Stanley

1. Very High Order Accurate TVD Schemes. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness. Springer-Verlag.

Pironneau, O.

1. (with Chacon, T.) Convection of Microstructures by Incompressible and Slightly Compressible Flows. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness. Springer-Verlag.

Rascle, Michel

1. Convergence of Approximate Solutions to Some Systems of Conservative Law: A Conjecture on the Product of the Riemann Invariants. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness. Springer-Verlag.

Schonbek, M.E.

1. Applications of the Theory of Compensated Compactness. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation and Methods of Compensated Compactness. Springer-Verlag.

Serre, Denis

1. A General Study of a Commutation Relation Given by L. Tartar. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness. Springer-Verlag.

Slemrod, Marshall

1. (with J. Flaherty) Numerical integration of the Riemann problem for a van der Waals fluid. To appear in Res. Mechanica.

Taylor, Jean E.

1. Complete catalog of minimizing embedded crystalline cones, Proc. Symp. Pure Math. 44 (late 1985 or early 1986).

Venakides, Stefano

1. The Solution of Completely Integrable Systems in the Continuum Limit of the Spectral Data. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation, and Methods of Compensated Compactness. Springer-Verlag.

Vogelius, M.

1. (with A. Damlamian) Homogenization limits of the Equations of Elasticity in Thin Domains. IMA Preprint No. 170, 1985.
2. (with R. Kohn) Thin Plates with Rapidly Varying Thickness, and Their relation to Structural Optimization. IMA Preprint No. 155, 1985.

Weissler, F.

1. (with C. Mueller) Single Point Blow-up for a General Semilinear Heat Equation. IMA Preprint No. 119, 1984. To appear in Ind. Univ. Math. Jnl.
2. (with L.A. Peletier and D. Terman) On the equation $\Delta u + \frac{1}{x} \nabla u + f(u)$, Arch. Rat. Mech. Anal., to appear.
3. (with M. Chipot) Finite time blow-up for a nonlinear heat equation with a first order damping term, in preparation.
4. (with R. Cazenave, A. Haraux, L. Vazquez) Nonlinear effects in the wave equation with a cubic restoring force. In preparation, almost complete.

Yee, Helen

1. Construction of a Class of Symmetric TVD Schemes. To appear in the Proceedings of the Workshop on Oscillation Theory, Computation and Methods of Compensated Compactness. Springer-Verlag.

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